SCIENCE

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NOTE ON THE "AGE OF THE EARTH."[1]

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ROUGHLY classified, there are four principal ways of estimating the duration of geologic time, of which two are geologic and two non-geologic. The first of these is based on sedimentation, and the second on erosion; the third is based on terrestrial temperature and supposed rate of cooling, and may be designated physical; the fourth method rests on inferences as to the cooling of the sun and other cosmic changes and conditions, and may be called astronomical.

The sedimentation estimate, as commonly applied, depends on an erosion estimate for its unit; usually it is assumed that the rate of degradation of the land is a foot in 3,000 to 7,000 years, and that in the long run the rate of sedimentation on the sea-bottoms of the globe is the same. The unit rate commonly accepted is that determined by Humphreys and Abbot from measurements of the matter transported by the Mississippi River, or one foot in 6,000 years = 1 mile in about 30,000,000 years. In earlier decades the aggregate thickness of sediments was usually placed at a few miles only, but probably no modern geologist acquainted with the results of researches in the Algonkian rocks of the Lake Superior and other regions would venture to estimate the total thickness at less than 50 miles; and this rate and thickness of sediments would indicate a period of 1,500,000,000 years for the deposition of the stratified rocks of the earth. It is probable that geologic process was more active in the earlier ages than at present; on the other hand, the deposition of the stratified rocks represents only the closing episode in the history of the earth — ages must have been required for the antecedent cooling and encrusting of the planet before the transfer of materials by hydric agency began.

Until recently the erosion estimate has seldom been applied, except as a unit for the sedimentation estimate; and even now it is applicable only to the later eons without the introduction of so many unknown quantities as to vitiate its results. Perhaps the most favorably conditioned region for the use of this method thus far studied is that found in eastern United States. Here rate-units have been determined from the measurements of recession of Niagara Falls and other cataracts, and these have been corroborated by measurements of the recession of Saint Anthony and other cataracts in the Mississippi Valley. These rate-measures and the measures of the volume of material removed from the gorges since the disappearance of the latest ice-sheet of the Pleistocene yield a fairly consistent chronometer for the post-glacial period, giving a value ranging from a few thousand to as many as 50,000 years. Toward the margin of the glaciated area in eastern United States there is another series of gorges, of which that of the Potomac, between Great Falls and Georgetown, may be taken as the type, representing erosion since the close of the Columbia period, or since the end of the first ice-invasion of the Pleistocene. A number of these gorges have been studied by Chamberlin, Salisbury, Gilbert, and others, as well as by the writer; and all geologists familiar with them are agreed that, if the post-glacial erosion is represented by unity, the post-Columbia erosion must be represented by two figures. These post-Columbia gorges themselves are excavated in the bottoms of many times longer and wider gorges recently shown to have been cut since the deposition of the Lafayette formation — e.g., the post-Columbia gorge of the Potomac is not over 12 miles long, a quarter of a mile in mean width, and 100 feet in mean depth, or $\frac{1}{17}$ of a cubic mile in content; while the post-Lafayette gorge of the upper river with its principal tributaries may fairly be put at 600 miles in aggregate length, 1 mile in mean width, and 250 feet in mean depth, or 30 cubic miles in content, or more than 500 times greater than the post-Columbia gorge.

The recent estimates for the post-glacial period derived from the Niagara and other gorges are shorter than of old, ranging from 5,000 to 10,000 years; it is not conservative to estimate the post-Columbia gorges at less than 20 or 30 times as old (assuming erosion to be uniform), or, say, 200,000 years. Now the post-Lafayette period is represented not only by the gorges trenching the Piedmont and Appalachian regions, but also by the widespread ravining and hill-sculpturing of the pre-Lafayette base-level peneplain of these regions, by great estuaries hundreds of feet deep and scores of miles broad traversing the coastal plain, and by the entire removal of two-thirds of the volume of the Lafayette formation (nearly all along and north of the Potomac) and extensive degradation of subjacent rocks, i.e., by erosion fully 500 times greater in the gorges and many thousand times greater over the general surface than the post-Columbia erosion; and it is accordingly hardly conservative to estimate this period at less that 20, 50, or 100 times longer than the post-Columbia period, or say 5,000,000 or 10,000,000 years. In this estimate allowance is made for the discrepancy between the figures based directly on relative erosion and those derived from the Humphreys and Abbot coefficient (1,000,000 or 2,000,000 years for the 200 or 300 feet of post-Lafayette degradation). It is, of course, to be remembered that erosion, *per se*, does not give a trustworthy time-measure, since stream-work is a function of declivity rather than time; but in eastern United States the physiographic conditions affecting stream-declivity have varied so little as to render the erosion-rate here exceptionally uniform.

In brief, while the erosion estimate of geologic time is subject to a large probable error, even to a considerable "factor of safety," the phenomena of eastern United States indicate an enormous lapse of time, probably reaching into millions of years, since the deposition of the late Neocene-Lafayette formation; yet this is one of the latest episodes in the development of the continent.

Combining the erosion estimate and the sedimentation estimate by employing the former so far as applicable and then using sediment ratios beyond, with a "factor of safety" beginning at 4 for the last and shortest period and raised to successively higher powers with each successive period and age counted backward into the past, the following values are obtained[2]: —

Period or Age.	Mean Estimate.	"F. of S."	Minimum Estimate.	Maximum Estimate.
Post-glacial period...	7,000	4	1,175	28,000
Post-Columbia.......	200,000	16	12,5 0	3,200,000
Post-Lafayette. ..	10,000,000	64	156,000	640,000,000
Cenozoic (including Lafayette)........	90,000,000	64	1,406,000	5,760,000,000
Mesozoic	300,000,000	256	1,172,0 0	76,800,000,000
Paleozoic.............	2,400,000,000	1024	2,348,000	2,457,600,000,000
Age of the Earth.....	6,000,000,000		10,000,000	5,000,000,000,000

[1] The meeting of the Geological Society of Washington, held April 12, 1893, was devoted to a symposium on the age of the earth, based chiefly on the recent article on that subject by Mr. Clarence King (Amer. Jour. Sci., vol. xiv., 1893, pp. 1-20); and these paragraphs are a revised abstract of remarks made on that occasion.

[2] American Anthropologist, vol. v., 1892, pp, 329-340. Through a simple and evident arithmetic error in this paper, Dana's ratios of 1, 3, and 12 for the Cenozoic, Mesozoic, and post-Cambrian Paleozoic are computed as 1, 3, and 36.

These general estimates are indefinite, and the minima, mean, and maxima are alike unworthy of final acceptance; but they stand for a real problem and not a merely ideal one, and represent actual conditions of the known earth; and, so far as the science of geology is concerned, the maximum estimate is quite as probable as the minimum, while the mean is much more probable than either.

As commonly made, the physical and astronomical estimates of the age of the earth are based on the assumption that the planet is (1) homogeneous, and (2) simple in structure. Thus the cooling of the earth would appear to be assumed analogous to that of a heated spheroid immersed in an ocean, and cooling at a rate determined by relative temperatures of spheroid and water, i.e., at a progressively decreasing rate. Now the actual planet is (1) heterogeneous and (2) complex in structure; and it may be questioned whether sufficient allowance is made for these facts in the non-geologic estimates.

By reason of terrestrial heterogeneity, the temperature of the earth's surface is not directly dependent on the relative temperatures of the terrestrial interior and surrounding space, but is chiefly determined by a complex and wonderfully efficient mechanism for collecting and conserving solar heat, in which the atmosphere and the liquid envelope play important *rôles*. Most geologists and physicists are of opinion that glacial periods might be explained by geographic changes, and hesitate to adopt such a theory only because of the dearth of positive evidence, or the existence of negative evidence, of such changes; and it is commonly recognized that, other conditions of sun and earth remaining unchanged, the earth might be materially chilled or warmed if the land and sea were disposed in zonal or meridional belts in such manner as to cut off or facilitate aqueous and aërial circulation. There is, indeed, reason for supposing that if the earth with its present mean interior temperature were divested of its heat-conserving mantles of air and water it would become a frozen planet. Thus, whatever may have been the case in the pre-geologic stages of planetary development, the present temperature of the external earth, and so its rate of cooling, depends on the sun rather than on the proper heat of the planet; and if (as is probable) the aggregate quantity of air and water enveloping the planet is diminishing, the efficiency of the terrestrial mechanism for conserving solar energy must have been even greater during the earlier ages of geologic development than now.

Again, the earth is complex in chemic constitution, and, moreover, it is probable, if not certain, that this complexity is correlated with temperature. If the course of terrestrial development, as commonly recognized, could be reversed for a time, the constitution of the earth-crust would be materially modified; as the temperature rose through a few degrees, the oxidation and fermentation of certain substances would doubtless be accelerated; with a few dozen degrees increase, life would be destroyed and the highly complex compounds manifesting that form of energy would be broken up; with a few hundred degrees rise, the coals would be consumed and the carbonaceous shales and limestones would be transformed, and these changes would be accompanied by profuse development of energy in the form of heat; and with a few thousand degrees increase in temperature, most of the compounds of the earth-crust would be modified or destroyed and the elements separated or re-combined in simpler forms. Consideration of the effects which would necessarily follow reversing the mechanism of planetary development indicates that the history of planetary growth is one of chemic differentiation coupled with molecular degradation, in which at least such molecular undulations as those of light and heat have progressively decreased in vigor. Moreover, this law appears to pervade the cosmos. It is probable that, as long since suggested by Kirkwood, the temperature of the cosmic bodies varies directly, while their chemic complexity (as determined by the spectroscope) varies inversely with their volume; and the meteorites, which give some indication of the constitution of other parts of the solar system, if not of still more distant portions of the cosmos, are made up chiefly of elements common to the earth, yet are united in frequently distinct and usually simpler compounds. Thus the phenomena of the planet, of the cosmos in general, and of meteorites appear to express a law of inverse relation between chemic constitution and temperature, i e., a law of chemic differentiation accompanying molecular degradation; and this law is in accord with the results of some of the latest researches concerning the ultimate relations of matter and energy. It follows that an aged planet like the earth must have stored up within it a vast amount of latent molecular energy; and incidentally that the law of cooling based on bodies of simple constitution is inapplicable. So it may be questioned whether the simple law of cooling, supposed to indicate the age of the earth, is more trustworthy than would be a formula for the volume-temperature relations of H_2O, derived from laboratory experiments on ice when extended to a body of the same substance passing through the gaseous, liquid, and solid conditions; or whether the simple law of cooling deduced largely from laboratory experiments conducted under circumscribed conditions are much more applicable to the highly complex earth than to the body of a hibernating animal.

In short, the geologic estimates of the age of the earth are based on direct observation under actual conditions so fully known, that, although certain factors are variable, all may be safely assumed to be known; while the factors involved in the non-geologic estimates — surface and sub-surface temperatures, thickness of the earth-crust, properties and conditions of rocks, etc. — must be furnished by the geologist, so that, at the best, such estimates represent nothing more than the grist ground from a mathematical mill; and, moreover, it usually happens that unknown factors are introduced to give texture to the product, but which, at the same time, so far adulterate the grist as seriously to affect its value. The geologic estimates concerning the age of the earth are based on real processes and actually observed conditions in such manner as practically to eliminate inaccuracies growing out of complex and unknown factors, and are thus strictly pertinent to the case; while the non-geologic estimates are based on ideal conditions immeasurably simpler than those actually attending a planet, and thus, interesting and instructive as they are in the abstract way, have very little to do with the concrete case.

It is significant that the discussion of geologic process by students who are not geologists is commonly trammeled in two diametrically opposite ways. The student of the "exact" sciences is seldom willing to grant so high a degree of mobility in the terrestrial crust as is required by the geologist to explain current continent movements, and is given to rejecting or ignoring the evidence of such movements; while, on the other hand, he is the first to reject as excessive the time-estimates of the geologist based in part on, and in complete harmony with, these observed movements. This mental habit, growing out of the methods and postulates employed in certain lines of study, is constantly to be borne in mind in weighing non-geologic opinion concerning the rate of geologic process, just as the opposite tendency on the part of geologic study is to be guarded against.

THE STANDARD COLOR SCHEME.

BY J. H. PILLSBURY, NORTHAMPTON, MASS.

IN *Science* for Feb. 26, 1892, I gave a brief account of a colo scheme, first proposed by myself in 1880, and set forth in mor elaborate form in a paper read before a meeting of the Society o American Naturalists held in Boston, Dec. 31, 1890. During th present year, through the courtesy of the Department of Physic of Wesleyan University, of whose laboratory and apparatus I wa allowed free use, the standards previously selected by the con sensus of a number of color experts have been located by wave lengths and, as far as possible, also by the prominent absorptio lines of the solar spectrum. Since there are vibrations of an ir finite variety of wave-length, any number of standards might b selected, but it is not, of course, desirable to select a larger num ber than the eye can readily distinguish. Six colors are clearl recognized by every normal eye in the solar spectrum, and th number has been chosen for the scheme of standard colors, a being both convenient and practical. These colors are red, orang yellow, green, blue, and violet. For the area of the solar spe

trum taken for measurement, which we will call the unit of the color, a patch of the spectrum obtained by a diffraction grating, representing a range of fifty ten-millionths of a millimetre in wave-length, was selected. This gives an area of color of convenient size for comparison, and one which appears quite homogeneous to the eye, even in those parts of the spectrum where the change is most rapid. The wave-lengths here given represent the centre of the area selected. The location of the standards with relation to the absorption lines of the spectrum, where such a location was possible, will give a convenient means of ascertaining the position of the standards I have selected without recourse to the elaborate method required in the use of the goniometer.

The Standard Spectrum Colors.

Color.	Wave Length.	Location by Prominent Solar Lines.
Red	6587	Above the "C" line.
Orange	6085	Between lines 6123 and 6066.
Yellow	5793	Between lines 5816 and 5763.
Green	5164	Between lines 5189 and 5139.
Blue	4695	No prominent lines.
Violet	4210	No prominent lines.

To obtain the intermediate hues, which it may seem desirable to introduce between these standards, these should be combined in inverse proportion to what the artists call the "value" of the colors. This is not, perhaps, easily determined, yet its approximate measure can be ascertained with sufficient accuracy for this purpose. These, however, are of much less consequence than the standards. Using Maxwell discs in these standards, the following formulæ will serve to illustrate, viz.:—

Orange Red R 70, O 30, Red Orange R 41, O 59.

Here the orange, having what the artist calls a higher "value," is used in a smaller proportion than the red. The same will be true in producing the tints and shades of any color. The amount of white or black to be used must be determined by the value of the color.

It has been urged in objection to the spectrum colors that they are not the colors of nature. In reply to this objection, it should be said that nature has no other colors than those of the spectrum. With these, however, are combined more or less of white light and shadow, producing the beautiful effects which so charm us in the landscape as it is spread out before us. For purposes of instruction, a series of what we may call "broken" colors is valuable. These are mixtures of the standards with both white and black, in given proportions. The amount of white and black must be determined, as in the case of tints and shades, by the value of the color. For advanced educational purposes, these broken colors are valuable, but should not be used until the student is well grounded in the knowledge and use of the standards.

The adoption of this scheme for practical purposes is also a subject of interest. By the use of the Maxwell discs, made in these standard colors, it is possible to determine the components of any color with which one may meet. The formula for such an analysis will enable anyone, by means of a similar set of discs, to reproduce the color with perfect ease. New combinations of color may also be produced with equal facility. In cases of experimentation, to ascertain what combinations of color would be harmonious, this is a great saving of time, labor, and cost.

The use of such terms as vermilion, emerald green, ultramarine, and other similar terms to express the results of analysis, is impracticable in the extreme, on account of the variability in the use of the terms.

Discs made in these standards are manufactured and can be furnished at a moderate price. These discs are at present made in pigments, which are excellent reproductions of the spectrum hues. Some of them, however, can be produced in the brilliancy required only by the use of analine colors, and these are not permanent when exposed to the light. For this reason they must be carefully protected when not in use and have to be frequently renewed.

MISSOURI OFFICIAL GEOLOGICAL REPORTS.

BY F. A. SAMPSON, SEDALIA, MO.

THE late publications of the geological survey of Missouri contain lists of the reports of the survey, which lists are not complete and give but a part of the official geological reports of the State; the four below mentioned should clearly be added to the list.

By an act of the legislature of the State approved Feb. 11, 1839, a Board of Internal Improvements was organized to have supervision and control over all State roads, railroads, slackwater navigation, or canals. The act provided for the appointment of a chief engineer, who should cause to be compiled "a large and correct map of the State" showing in "a correct and minute manner" the geographical, topographical, and geological features of the State. In his office should be kept "all reports of engineers, geologists, and other scientific persons, either contributed by individuals or ordered by the State." A supplemental act, dated two days later, provided for surveys of four rivers, the Osage, the North Grand, the Salt, and the Merrimac, and one railroad route, that from St. Louis to the Iron Mountain.

The members of the board were appointed by the Governor, and these were assigned as commissioners of the above five routes. A State engineer and a geologist of the Osage River survey were also appointed. The journal of the board and the reports of the chief-engineer and geologist are among the scarcest of the publications of the State. I know of no copy in the State except my own. It was published in the appendix to the Senate journal of the eleventh General Assembly, 1840–41, and probably in the House journal also, but I have never seen any copy of the latter, I know of no copy of either journal in any library in the State. The report I have I found in the tower of a court-house in Central Missouri, the journal part having been torn away, but leaving the appendix complete. The title of the report is "Report of a Geological Reconnoissance of that part of the State of Missouri adjacent to the Osage River, made to William H. Morrell, Chief-Engineer of the State, by order of the Board of Internal Improvement, by Henry King, M.D., Geologist, President of the Western Academy of Natural Sciences, etc., etc.," pp. 506–525.

Professor Swallow made a report on the southwestern branch, in obedience to the act of March 3, 1857, which required the State geologist to make a thorough survey along the lines of all railroads aided by the State, and to report in detail to the president and directors "all the mineral, agricultural, and other resources which may affect the value or income of the road under their direction." But one such report was published, but this is as much one of the official reports of the survey as any other of Swallow's reports. Its title is "Geological Report of the Country along the line of the Southwestern Branch of the Pacific Railroad, State of Missouri. By G. C. Swallow, State Geologist. To which is prefixed a Memoir of the Pacific Railroad. St. Louis: Printed by George Knapp & Co., 1859." 93 pp., plates and geological map of southwest Missouri.

Another edition of this report somewhat fuller was published in New York by the Pacific Railroad Company, but I have not seen a copy of it.

The third omitted report is a short one, but it could not have been omitted on account of that fact, as Swallow's third report is still shorter. It is entitled as follows: "Report to the Board of Curators concerning the Transfer of the Geological Survey to the School of Mines, and the work executed during the year. By Charles P. Williams, Ph.D., Director Missouri School of Mines and Acting State Geologist."

When preparing the bibliography of the geology of Missouri I found this report in the catalogue of the Missouri State University for 1876, pp. 213–216, a publication in which one would not look for a geological report, but for some years the catalogues of the university contained many papers of merit, as addresses and

lectures, contributions from the laboratories of the University and of the School of Mines, Bulletins of the Agricultural College, etc.

The latest of these omitted reports was found by me since the publication of the Missouri bibliography, in the House journal of the adjourned session of the twenty-sixth General Assembly, 1871-72, pp. 226-290, and I think it was not published except in that journal. Its title is "Report of Progress of the State Geological Survey. from August 30, 1870, to March 13, 1872. By J. G. Norwood, State Geologist, pro tem., State University, Columbia, March 13, 1872."

CHARACTER IN ANIMALS.

BY W. C. BARRETT, M.D., D.D.S., BUFFALO, N. Y.

MAN too often looks upon the lower orders as possessed of nothing but selfish instincts and impulses, and as being moved by nothing but animal appetites. He becomes a tyrant over them, and never for a moment dreams that they can comprehend his meanness and injustice. A little more of observation would remove this impression. Who that has been in close contact with any class of animals but can call to mind instances of the exercise of gratitude, real benevolence and magnanimity, that would do honor to the noblest human beings?

This is not confined to domestic animals, nor can the exhibition of special traits be attributed to their association with man. It is a truth which no observer will deny, that some are quite incapable of affectionate impulses. They seem to have sufficient intelligence, but like some men they are utterly and entirely selfish, while others are even morose and vindictive. There is as distinct and characteristic an individuality in their natures as in that of human creatures. It is an interesting exercise to study these personal peculiarities even in wild animals, and to detect the human traits which distinguish each. Birds that seek the companionship of man exhibit a wide variation in individuality. It is not difficult to obtain the confidence and trusting faith of some robins, for instance, while others are ever suspicious and distrustful.

I was once possessed of a common red squirrel, that was caught when but a few days old, and which had the most charming personal characteristics imaginable. I never saw in any human being a stronger and more marked individuality than this animal possessed. It was as playful as a young kitten, and delighted in the attentions of anyone of whom it was fond. It was as affectionate and as demonstrative as ever I saw a young child. It had withal a merry, playful mischievousness, that while it was at times vexatious, made it seem almost human. It was allowed to run about the rooms at will, and it found the most constant delight in entangling a piece of knitting or other work, and, when detected, in attaining some inaccessible height, then indulging in a chuckling kind of chatter. The chess table could never be set out with the animal at liberty, but that when the players became absorbed in the game and had forgotten all else, Jennie would suddenly alight upon the table, scattering rooks and pawns in every direction, and instantly disappearing up a curtain or into some nook in the book-cases. This would be repeated as often as the players forgot their surroundings, until it became necessary to catch her and shut her up in her cage. One could not lie down upon a couch, with a newspaper which he was reading held aloft over the head, but that like a lightning flash Jennie would light upon the paper or book, and instantly scramble away to some safe place, where she would absolutely chuckle at the success of the scheme. She never gnawed the furniture but once, for she never forgot the punishment which this brought.

She was subject to likes and dislikes, and every visitor who entered the room was carefully scrutinized. If it was a lady who was looked upon with favor, her hair was pretty sure to be pulled down by the demonstrations of affection, and out of a seeming pure love for good-natured mischief. If, on the other hand, the visitor was looked upon with distrust, he could never get near the animal. It loved to fondle those who were its favorites, and exhibited the utmost affection for them. Indeed, its attentions sometimes became too intrusive for comfort.

One unlucky day an accident deprived poor Jennie of her life, and I obtained another, caught at quite as early an age, and always treated with the same kindness and care. I had expected another such charming pet, but there was no more similarity in disposition than there might be between two utterly diverse children. The second animal was morose, sullen, vindictive, in every way disagreeable. The first one would never under any circumstances attempt to bite, while the second was at least always threatening it, and forever scolding and chattering, until at last I gladly gave it freedom in the woods and obtained a successor.

This one was unlike either of the others. It was not playful or affectionate, nor was it perverse and churlish. It was a complete exemplification of the miser, and its whole character was absorbed in its acquisitiveness. It was ever hunting for nuts and other things which struck its fancy, usually articles of food, which it carried away to a secret place in a closet. Occasionally these were taken out by some member of the family and placed in another room, for the purpose of watching the seeming exultation with which the squirrel made their discovery, and the enjoyment it appeared to take in carrying them away and again hiding them. It would run back and forth with such extreme assiduity that it would tire itself out and drop panting upon the floor, only after a few moments' rest to recommence the task. If the newly-found treasure were suddenly removed during its absence, there would seem to be the most poignant disappointment. The animal would for a time search anxiously for the vanished wealth, and then in succession visit the members of the family who were present, and seem to beseech its return, as if knowing that we were responsible for its loss.

There was never a moment during the day which was not spent in searching for something to add to its hidden possessions, or in arranging and rearranging its store. The animal, like some men, was so utterly absorbed in its avariciousness, that it had no time to devote to anything else. All affection was lost in its sordid nature. It had no special dislike for or fear of human beings, yet it sought solitude, apparently to enjoy the contemplation of its accumulations. It was unsocial, simply because of its covetousness. No human mind ever exhibited a meaner avariciousness, or a more parsimonious stinginess. It would suffer for lack of food, rather than take one nut from its great possessions. Its most salient characteristics were so disagreeable to witness that I finally gave the animal away, and after several other attempts gave up in despair that attempt to find another such cheerful, engaging, affectionate, trusting pet as the first one, being fully convinced that such characteristics are as rare among squirrels as they are among men and women.

CURRENT NOTES ON ANTHROPOLOGY. — XXIX.

[Edited by D. G. Brinton, M.D., LL.D., D.Sc.]

Modifying Agents of Skull-Form.

IT looks now as if Broca, however eminent in many branches of anthropology, was no wiser as a prophet than others of that genus when he ventured this prediction: "The day will come when the characteristics of all the races and their subdivisions will be so well known, that the study of a series of skulls will be sufficient to determine their origin."

It is in pursuit of the realization of this dream that craniologists have labored ever since, with the result that they are farther from the goal than ever. Now, the wiser among them are turning their attention rather to the history of the development of the skull and its parts, both in the individual and, comparatively, in the realm of animal life, and not endeavoring to use it as a standard for the classification of races and peoples. It is found that in certain instances the shape of the same skull varies materially with the age of the individual; that the tendency to reversion to one or the other type in the parents is by no means equal in all cases; that there are marked correlations with greater strength, viability, and sexual life, which give one or the other form an advantage in a given *milieu* above its associate; that the prevailing type of a geographical province seems to exert an influence

without direct intermixture of blood; that social planes, which mean different modes of life and nourriture, exert an influence; and so on. This is the newer science of craniology, more complex, indeed, but far more promising than the old study of dry bones alone.

Ethnic Ideals of Physical Beauty.

The *vis superba formæ*, the "proud strength of beauty," has never yet been sufficiently acknowledged as a formative principle in the evolution of racial and national types. Through conscious cultivation and sexual selection every individual strives more or less to possess and propagate those traits which the national imagination conceives as the comeliest. In a recent thesis, Dr. Loubier tells us from a wide reading of the French poets of the twelfth and thirteenth centuries what they portray as the ideal of manly beauty. It is this: tall, broad-shouldered, deep chest, slender figure, foot arched, skin white, hair blonde, quick eyes, high color, red lips. Evidently this is the High German type rather than that of the modern French; but the poets drew their heroes only from the nobles, and not from the common herd.

Some years ago, in an article on "The Cradle of the Semites," I had occasion to study the ideals of male and female beauty shadowed forth in the erotic composition known as the "Song of of Songs," or the "Song of Solomon," in the Old Testament. It dates from about 250 B.C. There the male is portrayed as "white and ruddy," his hair black and curly, his eyes gray ("like doves washed with milk"), his stature tall. He describes his bride as "fair all over, without a spot," slender, "like a palm tree" (not fat, as modern Oriental beauties), her hair "as a flock of goats," that is, wavy and light-brown, probably, her lips red, "like a thread of scarlet." The interesting feature in both these descriptions is that they point much more to the blonde than to the brunette type as that which hovered before the imagination of the sons and daughters of Israel as the realization of their amorous dreams.

The Easternmost Wave of the Early Aryan Migrations.

The Khmers of Cambodia have long been regarded as an isolated people of mixed blood and uncertain affinities. In a meritorious work published in Germany this year, Schurtz's "Kathecismus der Völkerkunde," the author refers to them as the probable aboriginal inhabitants of Cambodia. On the other hand. in the Mémoires of the Society of Anthropology of Paris, Dr. Maurel of the French Marine has a very able article, based on original observation, much of it anthropometric, going to show that the ancestors of these Khmers were the leaders of the easternmost wave of migration of the Aryan or Indo-European stock.

That they came from Hindostan and brought with them the Aryan culture of that country is proved by the stately ruins of their temples around Ang-kok, whose walls are decorated with bas-reliefs of scenes from the Ramayana. Their arrival was probably about the third or fourth century of the Christian era, and their route apparently was from the delta of the Ganges across lower Birmah and Siam. It is likely that even at this time most of their followers were non-Aryan and the leaders rarely of pure blood. In later generations they received a large infusion of Mongolian admixture from the tribes they found in Cambodia, who belonged to that race.

These conclusions are borne out by a close anthropologic study of the existing population and of the history and archæology of the country. If correct, they show that the mighty Aryan stock, wandering from its pristine seat in western Europe, reached in its eastern wanderings almost to the shores of the Pacific, on the China Sea.

The Evolution of the Idea of God.

Last year a book was published in both French and English by Professor G. D'Alviella, under the title, "The Idea of God as Illustrated by Anthropology and History," and it received a careful handling by the distinguished Professor Reville in the Proceedings of the Musée Guimet. From these two excellent sources we may take the last word as to the genesis of the notion of Deity, as understood by scientific minds.

It arises first from the association of the idea of personal life with that of motion; for instance, the swaying of the tree to the primitive man is as certain a proof of personal life as the flying of a bird. By extension of this, and later through dreams, memories of the dead, and casual associations of motionless objects with motion (as a rock in the midst of a rapid), arose spiritism or animism, to which these writers apply the general name "polydemonism." In this stage there is no Pantheon, no hierarchy of the gods, no idealized generalizations of divine powers.

This appears in the next stage, which is "polytheism," in which the mind of man seeks to coördinate the visible powers of nature, and to explain one by the other, thus subsuming a group under one abstraction, which becomes to him a personified idealized force. This is the epoch of mythology, which is at once an imaginary history and a tentative philosophy of the unseen agencies in nature.

The ultimate stage, monotheism, has various origins, depending on the ethnic psychology of the people among whom it arises. It may be an exaltation of the national god through national pride, so that he shall be "God of Gods and Lord of Lords," as seems to have been the case with the Israelites; or it may arise from concentrated devotion to one divinity to the mental exclusion of others, as in the so-called "henotheism" of ancient Egypt; or, again, in nations of uncommon speculative insight, it may be a purely logical deduction, as among the ancient Greeks. Most of the so-called monotheisms are in reality only "monolatries;" that is, there is worship of but one god, though many divine powers are recognized as existing.

The important point is urged, especially by M. Reville, that this sequence of development is not historical; it is not even ethnic; but strictly anthropologic; that is, the whole of the sequence exists contemporaneously and in the same locality with its highest member. Alongside of the pure speculations of Plato were the puerilities of paganism; and in modern Christian communities there are far more polydemonists and polytheists than monotheists, in the scientific sense of that term.

Both writers reach the opinion that the religious sentiment is not a passing phase of human mental evolution, but a permanent trait; and that, though all existing cults and creeds may pass away, it will only be to give place to nobler ideals of humanity and loftier conceptions of divinity.

NOTES AND NEWS.

A SERIES of international congresses, under the auspices of the World's Congress Auxiliary, and the authority of the Government of the United States, will be held in Chicago during the progress of the World's Columbian Exposition. The Congress of Anthropology will begin on Monday, Aug. 28, and will continue until Saturday evening, Sept. 2, 1893. It is requested that the title and abstract of any paper to be offered to the Congress be forwarded as early as possible to the secretary of the Local Committee, with a statement of the time required for its reading, in order that the Congress, at its organization, may have the material for the arrangement of the programme for the week. The committees of the International Anthropological Congress are: Local Committee of Arrangements, F. W. Putnam, chairman, C. Staniland Wake, secretary, Edward E. Ayer, James W. Ellsworth, H. W. Beckwith, and Frederick Starr; Executive Committee, Daniel G. Brinton, president; Franz Boas, secretary; W. H. Holmes, representative of the American Association for the Advancement of Science; W. W. Newell, representative of American Folk Lore Society; Otis T. Mason, representative of Anthropological Society of Washington; Alice C. Fletcher, representative of the Women's Anthropological Society of America; Louis A. LaGarde, representative of United States Army Medical Museum; and the presidents and secretaries of the Sections of the Congress. Address all communications to Professor C. Staniland Wake, Local Secretary, Department of Ethnology, World's Columbian Exposition, Chicago.

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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

THE FORMATION AND DEFORMATION OF MINNESOTA LAKES.

BY C. W. HALL, MINNEAPOLIS, MINNESOTA.

In respect to inland waters Minnesota shows conditions which are exceptional in North America. Exclusive of that portion of Lake Superior within her boundary, the State has 5,700 square miles of lakes varying from a few acres to the size of Red Lake, which has 340,000 acres in its area. These lakes are conveniently divided into three classes.

First, rock-bound lakes. These bodies of water occur chiefly in the northeastern portion of the State. They occupy the troughs in the crustal folds that have contorted the surface, or the depressions where excessive faults have broken and considerably tilted the strata. These, as a rule, are long, narrow, and deep. The water is clear and sparkling, abounding in fish, and remarkably free from the various forms of plant growth peculiar to shallow waters.

Second, silted-river lakes. These lakes occur in rivers where rapid streams have brought down a deposit into the channels of the more sluggish ones, the silting debris being so course that the slower current fails to transport it. Thus slower streams are choked up and the water set back for miles. Such lakes are Lake Pepin, formed where the sluggish Mississippi is dammed by the debris brought into its channel by the more rapid Chippewa River, Lake Saint Croix, Lake Lac qui Parle, and many others.

Third, glacial lakes. If this group could be minutely subdivided, there would be seen several types of lake formation. Those of the Lake Agassiz type, where one portion of the shore consisted of a wall of ice, have long since disappeared and left scattered pools of varying sizes, occupying the depressions in the generally level surface of the old lake bottom. Going outside of the State for an illustration, we may name Lake Winnipeg as the largest pool now remaining in the bottom of glacial Lake Agassiz. Many other lakes are scattered over the level portions of the State, occupying the depressions in the drift-sheet where this was laid down evenly through the steady and uniform movement of the ice, or through the silting effect of waters due to the melting of the ice border.

But by far the greatest number of lakes in Minnesota are those occupying the depressions in the unevenly distributed morainic matter deposited during glacial times. Portions of the State are thickly studded with these beautiful sheets of clear water. The region between Minneapolis and the Red River valley is appropriately called the Lake Park Region, as lakes occur here in vast numbers. Wright County, nearest to Minneapolis, contains 259 lakes, Kandiyohi County contains 286, and Ottertail County, well up towards the borders of glacial Lake Agassiz, holds the banner over 430 lakes. Passing northeastward from the Lake Park Region towards Ontario, past the head-waters of the Mississippi, and across the upper streams of the St. Lawrence River basin, we pass gradually from the region of moraines to the region of thin glacial deposits and constant and tumultuous rock-exposures, carrying large numbers of lakes of the first type.

It has been frequently estimated that Minnesota contains 10,000 lakes. To one passing over the State through the region named this does not seem an exageration. There must be several thousand lakes from one mile in length upwards to the very largest.

While glacial lakes show many varieties of form due to the position of tongues, branches, and subdivisions of the moraines, they are generally circular in outline. The deepest portion is at the centre. Their shores show but few successive beaches to indicate erosion at their outlets and consequent drainage, or great variation in the amount of rainfall during the last few thousand years. They were all evidently formed in the same general manner, by the washing down of fine silt from the high land into the bottom, thus gradually filling the interstices in the gravels and sands beneath them, making water-tight bottoms to hold the water. Probably the lakes were small at first, and enlarged gradually as this deposition of fine silt extended their borders until the lowest point in the margin was reached and an outlet drained away the excess of water. When this outlet was reached the conditions of formation ceased, and the conditions of deformation became manifest. Material was constantly washing in from the high lands around through the melting snow of successive springs and the heavy showers and rain-storms of the summer months; it was also brought by streams flowing into the lakes from every direction, and formed *in situ* by the vigorous growth of aquatic vegetation. In the shallower lakes this last cause of deformation works with great rapidity. After the ice disappears in the spring under the warm sun of this latitude the water very rapidly rises in temperature to 70° or 75°, a favorable temperature for vigorous vegetable growth, and thus plant-forms which can get foothold upon the lake bottom will develop a vast amount of plant debris. Already hundreds of the shallow, small lakes of the State have disappeared, and rich, productive hay-meadows have taken their place. This will be the fate of thousands more within the coming century. On every hand we hear old settlers speak of large lakes once affording superb hunting ground for wild geese, ducks, and other water fowl and excellent fishing, as now either hay-meadows or extensive marshes soon to be fitted for hay production by a further lifting of the surface above the level of the outlet through this rapid accumulation of the vegetable mold.

The lakes of Minnesota afford some of the most attractive summer resorts to be found in our northern States; as already famous can be mentioned Minnetonka, White Bear, the Chisago Lakes, and Waconia. The list can be indefinitely extended. Their climatic influence is very marked. The amount of heat stored up during the summer, if calculated by its mechanical equivalent, is enormous. With 43° as the average increment in temperature, 10 feet as an average depth of 5,700 square miles of water surface, we have nearly 11 cubic miles of water. Since each cubic foot of this water receives 1,250,000 foot pounds of heat, which must be given off during the autumn months as these lakes gradually settle down to the freezing-point of winter, the amount of heat thus made available for our autumn weather reaches quintillions of foot pounds. This warmth is a break against early autumn frosts. The south side of Lake Minnetonka has most productive vineyards and fruit gardens, while the northern side is liable to early frosts.

Other writers have called attention to the distribution of fresh-water lakes. They are almost wholly confined to the glacial regions of our globe. Northern Europe and northern central North America, with other isolated portions of the globe, are the only places where many bodies of fresh water are found. It remains to be noted that within these glaciated regions the oldest portions are already comparatively free from lakes. The southern border of the glacial area of the United States is almost wholly devoid of them. The vast prairies of Ohio, Indiana, and Illinois have but few, yet there are vast agricultural tracts within these States which show deep and rich accumulations of vegetable mould, evidence of former aquatic plants. Doubtless there were once thousands of lakes within these States, but the silting-in of

mineral debris and the growth of vegetation have filled them up, and thus altered the whole face of the country, a result soon to be very marked within Wisconsin, Minnesota, and the Dakotas. Indeed, the years can almost be counted when glacial lakes within these States will be rare indeed.

The question how long a period of time has elapsed since the retreat of the glacial ice-sheet from the central portion of the North American continent cannot be here discussed. Yet, by way of suggestion, it may be said that, if the filling-up of glacial lake basins be a chronometer useful in measuring geological time, the rate at which these lake basins are now filling up and disappearing, and the fact that they have already disappeared from the southern portions of the glaciated area, are strong presumptive evidence that the ice of the glacial period lingered longest in the region between Lake Michigan and the Missouri River to the north of the 44th parallel, and that here the time since its disappearance has been comparatively brief; indeed, that the estimates of Gilbert, Wright, Winchell, Upham, and others are long enough to explain every phenomenon save, possibly, that of the redistribution of plants.

The two remaining lake types are more permanent. Rivers will continue to be silted and their currents choked so long as two streams of varying transporting power merge into one. Rock basins will continue to hold water so long as the conditions of erosion are unfavorable through the obdurate resistance of crystalline rocks, and plant growth is discouraged through the lack of soil, as is now the case around the margins of the rock-basin lakes of northeastern Minnesota.

THE ROYAL SOCIETY OF CANADA.

THE twelfth annual meeting of the Royal Society of Canada was held at Ottawa, Canada, during the week beginning May 22, and terminated its sessions on Thursday evening, the 25th.

The meeting opened under the presidency of Dr. J. G. Bourinot, C.M.G., clerk of the House of Commons, etc. The meeting was very well attended by fellows and delegates.

The society divides itself into four sections, as follows: I. French Literature and History; II., English Literature and History; III., Mathematical and Chemical Sciences; IV., Geology and Biology.

Amongst the papers which interest the readers of *Science* most were those of Sections III. and IV., besides the "Science Lecture" given to the public under the auspices of the Royal Society in the Assembly Hall of the Provincial Normal School.

The president's inaugural address dealt with "Our Intellectual Strength and Weakness," which received most favorable comment

The public science lecture was delivered by Dr. Ramsay Wright, professor of biology and histology in Toronto University. His subject was, "The Natural History of Cholera." In a masterly manner Professor Wright treated his subject, and described this minute microscopic plant through all its phases and life-history in a simple, clear, and practical manner, throwing a flood of light and giving an amount of information of great value.

In Section IV. Mr. Whiteaves gave the presidential address, in the course of which he summed up the result of researches in the Cretaceous formations of Canada. In the course of his address Mr. Whiteaves showed that in Canada no less than 600 species of fossils were known from the Cretaceous rocks of the Northwest Territories, of the Rocky Mountain region, and of the coast and islands of British Columbia. Of these some 450 were marine invertebrates, mostly shells, and characterized the two divisions into which the Cretaceous system was divided in Canada, viz., the Earlier and Later Cretaceous.

Sir William Dawson had described or identified no less than 115 species of plants from the Nanaimo, Queen Charlotte Islands, and British Columbia Cretaceous basins. Mr. Whiteaves himself had devoted his attention to the invertebrate and vertebrate faunas (*partim*), whilst Professor Cope had in his hands a number of the deinosaurian remains which characterize certain horizons of the Cretaceous in the Prairie region of the Northwest.

Then came Sir William Dawson's paper, entitled "Additional Notes on Cretaceous Plants from Port McNeill, British Columbia." The collection made by Dr. G. M. Dawson at this place was cursorily noticed in a note printed in the Transactions of this Society (1888, p. 71, Sec. IV.). As the collection is large and the specimens unusually perfect, and some of the species are new and very interesting, it has been thought desirable to prepare more detailed descriptions, more especially as these plants belong to either a station or a horizon somewhat distinct from those so familiar in the coal-fields of Nanaimo and Comox on the other side of Vancouver Island.

This paper was followed by another from Mr. Whiteaves, "Description of Some New Species of Fossils from the Trenton Limestone of Manitoba." This was a continuation of two others on the same subject which have already appeared in the Society's Transactions. It contained descriptions and illustrations of several species of Cephalopoda and of one rugose coral.

Dr. Ells then read a most interesting contribution on the geology underlying Northumberland Straits: "The Geology of the Proposed Tunnel under the Northumberland Strait between New Brunswick and Prince Edward Island." The paper discusses briefly the several geological formations which border on that portion of the Gulf of St. Lawrence adjacent to the Strait, with reference more particularly to the several members of the Carboniferous system, the rocks of which have a very considerable development in this area. The proposed tunnel, according to its present location, will traverse these between Cape Tormentine, in New Brunswick, and Carleton Point, in Prince Edward Island, and the description of the strata which will probably be encountered is given, as shown by the series of bore-holes put down during the past season along the line of the principal route.

Dr. Ells was elected fellow of the Royal Society at its last meeting, and has, through his numerous papers and writings on the geology of Canada, contributed much new information regarding the economic minerals, as well as some of the most intricate problems of geology, chiefly in New Brunswick and Quebec.

Mr. Lawrence M. Lambe contributed his second paper on "Sponges from the Pacific Coast of Canada." The paper describes the sponges collected by Dr. G. M. Dawson in the vicinity of Vancouver Island and the Queen Charlotte Islands. There are, all told, about twenty species, seventeen of which are siliceous.

Mr. W. Hague Harrington read a paper on the "Canadian Uroceridæ," in which descriptions, synoptical tables, and lists, together with remarks on the occurrence, distribution, etc., of the species, are given, whilst the Rev. G. W. Taylor of Victoria, B.C., presented "A List of the Land and Fresh-Water Mollusca of Canada, with Notes on their Distribution."

Mr. G. F. Matthew of St. John, New Brunswick, so well known for his valuable papers on Cambrian geology and palæontology, was to the fore with three papers or contributions:—

(*a*) "Illustrations of the Fauna of the St. John Group, No. VIII.," contains descriptions of new species from Band *b* of Division 1, and Band *b*, Division 3; also forms from Division 1 *b*.

(*b*) "On Some Remarkable Organisms of the Silurian and Devonian Rocks of Southern New Brunswick, No. 2." A paper on certain species of the above formations was read before the Royal Society in 1888. The present article contains descriptions of a few others, all of which are from the well-known plant beds of Lancaster, near St. John. These were found by Mr. W. J. Wilson, now of the Geological Survey of Canada. 1. The wing of an insect of the genus Homothetus. 2. A new species of scorpion. This species is of Silurian (Upper) type; the thoracic shield, which is unusually narrow, is the only part certainly known. 3. A new land shell; it resembles *Strophites grandæva* of Sir Wm. Dawson, but is larger and proportionately more slender. 4. A millipede, a minute species, belonging to the division Chilopoda; of which the body is not complete.

(*c*) "Traces of the Ordovician System on the Atlantic Coast." This system has not heretofore been recognized by its fossils on the Atlantic Coast of America, except at St. John, where the oldest part of it (Arenig horizon) is folded in with the Cambrian rocks at St. John. We now recognize it at two other points, viz., Conception Bay, Newfoundland, and Bras d'Or Lake, Cape Breton.

In both these localities the fossiliferous beds consist of gray sandstones holding a fauna of European facies, several of the species being common to these and the Russian deposits. Overlying the Ordovician strata at Conception Bay are the sandstones of Great Bell Island, which, as they contain Brachiopods of the Trimerellid family, are probably Silurian (Upper). The fossiliferous Ordovician deposits in New Brunswick and Maine are either fine, dark shales and slates or siliceous mud-rocks, and indicate the probable existence of one or more deep-water sounds in Ordovician times partly shut off from the ocean over the area of the Acadian provinces.

Mr. G. U. Hay contributed an interesting paper, which received hearty endorsement and well-merited comments, on the "History and Present State of Botany in New Brunswick." The subjects dealt with in this paper are: 1. The History of Botany in New Brunswick, referring briefly to the explorations made by botanists in this and the neighboring provinces in the first half of the present century, noting the discoveries of plants made and the partial or fragmentary lists, chiefly of forest trees. Of these lists, probably one of the earliest and fullest is that by Sir James E. Alexander, preserved in his second volume on "L'Acadie," and comprising over one hundred species of plants, shrubs, and trees collected between Petitcodiac and Boiestown. 2. The Present State of Botany in New Brunswick, showing that a fairly complete survey of the Phenogamous flora of the province has been made, with the result that lists aggregate between nine hundred and a thousand species of flowering plants. A beginning has also been made in the cryptogamous flora by the preparation of short lists of mosses, lichens, and algæ. The economic importance of a wider and more general study of this subject is urged, especially with regard to agriculture and forestry; the collection of information on the time of flowering of plants and the ripening of fruits each year at many stations throughout the Province; more attention paid to the medicinal plants found in the Province, and more general and systematic attempts made for the extermination of weeds.

Three more geological papers were on the programme, but, on account of the gentlemen who were to read them being absent or engaged in the work of other sections, they were "read by title." These are as follows: "Note on the Gold-Bearing Ore of the Crawford Mine, in Peterborough County, Ont.," by Professor E. J. Chapman, LL.D. "Notes sur le forage d'un puits artésien dans le quartier du Palais, Québec," par l'Abbé J. C. K. Laflamme. Ce puits a été creusé dans un terrain dont l'horizon géologique ne semble pas encore absolument établi. L'examen des échantillons qui en ont été tirés pourrait être de nature à jeter un peu de lumière sur ce problème de stratigraphie. "Note sur la valeur de l'ouvrage de J. Cornuti sur les plantes du Canada," par l'Abbé J. C. K. Laflamme. L'auteur, dans sa monographie sur M. Sarrazin, avait déjà donné des détails capables de servir à l'histoire des sciences au Canada. En examinant l'ouvrage de Cornuti, publié longtemps avant les travaux de Sarrazin, il espère ajouter une page à peu près inconnue au plus grand nombre de nos botanistes. L'ouvrage de Cornuti a été imprimé à Paris en 1634. Par conséquent, dès le commencement de la colonie, on y a toujours prêté le plus vif intérêt au développement des sciences, et les travaux qui ont été faits sur ce point ont une valeur réelle.

Altogether the meetings were a great success. Dr. George M. Dawson, C.M.G., etc., was elected president of the Royal Society, and Dr. Bourinot honorary secretary. HENRY M. AMI.

THE PLACE OF THE LABORATORY IN TEACHING PHYSICS.

BY A. D. COLE, DENISON UNIVERSITY, GRANVILLE, OHIO.

THE use of laboratory methods in teaching physics has become almost universal in American colleges. But it may well be questioned whether the usual plan followed is the best one. Most colleges require elementary physics as a condition for admission, but this preparation is usually obtained in schools where no opportunity for systematic laboratory work is given, and the student enters college completely ignorant of laboratory manipulation, sometimes indeed without having even seen his teacher perform experiments. In his sophomore or junior year he takes a lecture course in general physics, and at the same time or the year following, a laboratory course. This latter course, however, is often elective, so that many students graduate from college without any laboratory knowledge of physics whatever.

But suppose one does take the laboratory course, is it well adapted to his needs? It often has very little connection with the lecture course, and is conducted by a different instructor. The student begins his work with no training in the accurate use of either hand or eye. Yet his first problem is often a difficult one, involving the skilful handling of complicated apparatus. He does not understand his instrument, turns to reference manuals, but finds their explanations are too general to help, or refer to a form of apparatus differing from his. The instructor cannot help him at once, as he is busy with some other bewildered student. He waits awhile, appeals to a neighbor in vain for help, finally makes a desperate start and at once succeeds in getting his instrument completely out of adjustment. When the instructor does finally get to him, it perhaps takes all the time that can be spared him to get the apparatus adjusted for a fresh start. Two hours have passed, and almost nothing accomplished. This is no fancy sketch. The writer has seen just such cases repeatedly, in several of the best-known laboratories in the country. Is it any wonder that students so misused find physics "hard" and uninteresting? The trouble is not with their work, but they have not been prepared to do it. Yet they can be prepared and with no greater expenditure of time.

Instead of giving the student ninety to a hundred and eighty experimental lectures as a preliminary to such work, give him about half that number, and in place of the other half let him demonstrate for himself the principal facts of physics in a series of about seventy-five measurements, requiring only moderate precision, in order that he may have time for a sufficient number of experiments to fairly illustrate his lecture course. Let him do this while the lectures are in progress, not after they are finished. Let the lectures be given say twice a week, on the other three days of the week give one hour to laboratory practice, and a half hour to recitation on the work of the day and the lecture of the preceding day. Keep laboratory work and lectures in close connection. The ideal method is to have all the class work simultaneously on the same subject — one connected with the lecture of the preceding day — and to conclude with the half hour of recitation.

Of course it is impracticable to duplicate apparatus to such an extent as to carry this system out perfectly, but if the class is divided into pairs for work, and each pair be provided with their own set of the instruments of frequent use, such as metric rule, hand-balances, dividers, test-tubes, etc., a considerable number of the earlier simple measurements can be carried on by all simultaneously. Thus a few glass tubes with the articles named above, will enable a whole class to study the laws of capillarity together, with an approximate verification of the law of diameters.

Where but few duplications of apparatus are possible, five or six different experiments may be going on together. To prevent confusion and loss of time, the apparatus necessary for each is placed by itself, and with it a paper describing briefly the method to be followed and giving references to books kept in the laboratory for the purpose. Each paper may be designated by a number, and each working pair is assigned one of these numbers. A class (or division) of twenty can thus get to work in one minute. For example, suppose the class is just beginning the consideration of specific gravity. Various methods of determining it have been described in the lecture of the day before. The ten working pairs are sent to the desks, where there are sets of apparatus illustrating five different methods, each duplicated once. One is arranged for finding the specific gravity of glass by the hydrostatic balance, another for that of lead by Nicholson's hydrometer, a third for that of quartz by the specific gravity flask, a fourth for alcohol by Jolly's balance, a fifth for mercury by Hare's communicating tubes. On the next laboratory day, each

division takes a second one of the five methods, and so on till each has had them all. Lecture and laboratory exercise have helped each other. Each one understands the subject and is prepared to enjoy and profit by the more careful measurement of specific gravity with delicate balance and corrections for variation of temperature and pressure from standard conditions, that awaits him in his term or two of advanced practical work. Such a course prepares him fully for the higher grade of work, so that neither inherent difficulties or imperfect explanation can now be a bar to progress.

It must be admitted that the method presented involves some additional effort on the part of the instructor, but there is abundant compensation in the superior results obtained. If space permitted, I would add something concerning methods of securing at small expense the duplication of apparatus necessary to keep the laboratory studies in close connection with lecture and classroom work, but that would better be reserved for another occasion.

DISCOVERY OF ANCIENT ARGILLITE QUARRIES ON THE DELAWARE.

BY HENRY C. MERCER, DOYLESTOWN, PA.

THE discussion of the Trenton gravel specimens has forced several important questions upon our attention. Where did the argillite come from with which the chipped objects were made? Granted that much of it was found in the river-bed in the shape of boulders and erratic blocks, whence had this material been transported by the river?

To learn that modern Indians on the Delaware quarried jasper and in the process of blade-making strewed the quarry site with "wasters," resembling in form the Trenton specimens, was to ask whether they also quarried argillite.

We had found argillite "turtle-backs" on the surface at the camp-sites of Gilmer's Island, Gallows Run, Ridges Island, and Lower Black's Eddy on the Delaware, but they lacked the final and convincing association with the quarry to prove their pedigree, and we still sought the whereabouts of the ancient pits, the refuse heaps, and the "rejects" or blocked-out implements which were to repeat in the now famous blue stone, the story of the inchoate blades of jasper.

The way towards an answer to one of the vital questions that concerns the antiquity of man in the Delaware valley was opened on May 22, by the discovery by me of a series of seven or eight depressions surrounded by masses of argillite chips (a quarry in fact with all the surface characteristics of Macungie, Vera Cruz, and Durham, in America, or Grimes Graves, or Spiennes, in Europe) on the steep north slope of the hillside at Point Pleasant, Bucks County, Pennsylvania, on the right bank of Gaddis' Run, about one-quarter mile above its mouth and half a mile from the well-known Indian camp-site at Lower Black's Eddy. The work of carefully clearing out one of the depressions and trenching its refuse heap was begun yesterday afternoon and will occupy an indefinite time.

Notched in the slope whose angle is about 35 degrees, the depression, one of eight or nine others, fronts a solid ledge of argillite (an outcrop of the large vein here traversed and exposed by Gaddis' Run, and twice tapped near by, by modern quarries as the purest source of the material).

Its largest diameter is about thirty feet, its depth five, and breadth eight. The trench begun across its narrowest width, penetrating for three feet through loose yellow mould, has shown as yet nothing of importance beyond two bits of charcoal and broken (quartzite pebble) hammer-stones at a depth of one and one-half feet. Another excavation about three feet in diameter has entered the mass of refuse for four feet without reaching its bottom, and discovered at various points thirty-three "turtle-backs," twenty-five broken bases or points, and four hammer-stones. On the surface about the other pits I gathered in a few hours twenty "turtlebacks," six ends or points, and fourteen hammer-stones.

With the work of penetrating to the bottom of the refuse, and studying the ancient quarrying process scarcely begun, I have hardly had time to more than think of the important questions suggested: Who made and worked the quarry? Will it show a successive series of occupations? Can it be connected with the village site at Lower Black's Eddy? What shall we say of these rudely chipped forms? Are they "wasters" and do they of all "wasters" yet heard of, resemble the Trenton specimens?

We are twenty-five miles above Trenton and at the largest and purest outcrop of argillite on the right river bank above that place.[1] The bed of Gaddis' Run and the river-shore below its mouth are thickly strewn with argillite blocks and water-worn boulders — a pathway, in fact, littered with blade material, extending, from the ledge above referred to, to the Indian camp half a mile distant. While the significance of this has been obscured by chipped fragments from the modern quarries fallen into the stream, and the stone dressing that has accompanied the building of a dam, two bridges, and a canal aqueduct, there can be little doubt that the inhabitants of the village often went no farther than a few hundred yards along these beaches for their material.

But too much hangs upon the further examination of this site and the neighboring camp, now at last unfolded to the student in its fuller significance, to warrant a premature word.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Science Work at the Avalon Summer Assembly.

I HAVE just received a little blue pamphlet containing the announcement of the new summer school at Avalon, New Jersey, and an extremely interesting and suggestive address on "Science Teaching in the Schools," by Dr. Charles Dolley, its president. Copies of this, I have been told, may be had by writing to Mr. Charles Adamson, secretary, 119 S. 4th Street, Philadelphia, Pa. The objects and methods of this new school are so new and attractive that it certainly marks the beginning of a new era in the teaching of science and art in our common schools.

The keynote of Dr. Dolley's address is struck by the following sentences in speaking of the proper method of educating the coming generation: "They begin by moulding little birds' nests of clay, or constructing cones and cylinders, cubes, and octagons out of paper, without ever having examined a bird's nest, other than that of the sparrow under the eaves, and knowing absolutely nothing of the interest to be found in a prism of quartz, a snowflake, or an icicle. They have been taught of the distribution of whales and camels and all sorts of exotic varieties, but are absolutely ignorant and blind to the wonders of nature to be found at their very doors; wonders requiring no text-books, no costly instruments, but which may be investigated by means as simple and inexpensive as the key and kite string of Franklin."

How few the teachers, let me add, who have the slightest inkling as to the wonderful history written in the chalk or slate they daily use!

Missions and philanthropic societies do good work in this world, but much is wasted. "What is needed," says Dr. Dolley, "is a sanitary missionary in every home, and this we can secure by training the children, by awakening in their minds a desire for something better, for more sunshine, more flowers, a wider horizon and more wholesome surroundings." How few the housekeepers who know the slightest whit about the yeast they use, the mother and flowers of vinegar, the moulds on jellies, the cause of rancid butter, or the nature of contagion! "The tritest things of our mortal experience are the most mysterious." There is enough of interest in a mucilage bottle to keep a man studying a lifetime.

[1] On Dark Hollow Run (below New Hope) I found a small vein of it nearly two miles from the river. The blue slate in Pidcock's Creek, on the south slope of Bowman's Hill and at the Harvey and Van Hart quarries below Taylor'sville, lacks the conchoidal fracture.

The above quotation is the tenor of that admirable article which ought to be read by every person interested in education and the welfare of his children and country.

Children are born with a love for nature which usually later leaves them. They are of an inquisitive turn of mind and admire flowers and birds while very young, but this is soon smothered instead of being fostered by text-book work and the common method of poking facts into reluctant brains in an ill-ventilated schoolroom by a teacher who knows all about the recent advances in pedagogy but nothing about the subject he is teaching.

The training of the senses of observation, of the faculty of reflection, and of the using of the hand, constitutes an education. One thus trained can get ten times more out of life than the bookworms who feed on second-hand facts.

The students — and the very youngest students — must be reached, and the manner of reaching them is through the teachers. For this purpose the new summer school at Avalon has been established. The work in natural history will be mostly out-of-doors. The students will go with the teachers out among the dunes, in boats about the bays and thoroughfares, among the marshes and along the shore, gathering plants and animals for study. The students in art will sketch right out among the bright-colored sand dunes and study the richness of color which characterizes those beaches and marshes by the sea.

Dr. Charles Dolley is the president and leading founder of this institution. He was formerly Professor of General Biology in the University of Pennsylvania. He was long a student and near friend of Dr. Joseph Leidy, whom, in his character and broadness of views, he resembles. He is a close student of nature, versed in both languages and science, and possessed of such personal magnetism and pleasing manners that he is always surrounded by many friends and admirers who are always helped by his never-failing enthusiasm and encouragement. A better person could not have been chosen for such a position.

The place selected for this summer school is a good one. Plenty of good material for science work is near at hand. It is the only beach on the coast where beautiful forests of red cedar and holly are still standing. There is a long even beach, unexcelled for bathing and carriage and bicycle riding. There are high white sand dunes and beyond vast stretches of salt marshes intersected by many bays, thoroughfares, and salt ponds. On the mainland there are forests of pines and many beautiful plants peculiar to the "low pine barrens of south Jersey."

For a sum not exceeding $50, including all expenses, a teacher can spend five weeks pleasantly and profitably at the seashore, not only bathing and enjoying the salt sea air and the other pleasures of such a result but breathing in a kind of knowledge which they will relish and impart to those under them and thus help to bring about this change in the manner of common school education for which many are hoping. JOHN GIFFORD.

Swarthmore, Pa.

Early Man in Minnesota.

IN *The American Geologist* (April, 1893) Mr. Wm. H. Holmes has published another long article, this time endeavoring to show that there is no evidence whatever of the existence of early man in Minnesota. The article is very prettily illustrated with fanciful sketches, which Mr. Holmes's practice as an artist makes him to evolve from his inner consciousness, and which he employs in all his writings in place of arguments in support of his theory of the non-existence of palæolithic man in North America.

He says that "Besides the investigations of Professor Winchell and Miss Babbitt, no work has been done upon the archæology of this region, although other writers, notably Mr. Warren Upham, Professor G. F. Wright, and Mr. Henry W. Haynes, taking for granted the correctness of all the original observations and conclusions, have ventured to enlarge upon the material published."

The only "venturing" I have done has been to express to the late Miss Babbitt, who sent to me for examination a large quantity of pieces of quartz collected by herself, the conviction that these fragments were of artificial and not of natural origin. As Mr. Holmes calls them Indian refuse, I can scarcely be charged with very hazardous venturing. Miss Babbitt wrote to me that she had discovered them in undisturbed deposits of glacial origin. If this is true, as I have no reason to doubt it is, certain objects among them presenting the palæolithic type must of necessity be true palæolithic implements, and not, like many of a similar type that have been found on the surface, be of doubtful origin. Every one knows that such objects are also sometimes found in Indian shell-heaps and village sites. Accordingly, whether any particular object can be positively identified as a true palæolithic implement or not depends upon the conditions of its occurrence. That is a question for geologists to answer, and if they pronounce the site to be of glacial origin the probability is very great that similar objects found in the immediate vicinity are also palæolithic implements. This is the state of the question with respect to the objects found in the Trenton gravels. How does this reasoning apply to the so-called Babbitt quartzes? The glacial man in fashioning palæolithic implements must have produced a great many splinters and fragments, just as the Indian did in producing his implements. If any particular locality offers only one available material to work with, the refuse of palæolithic man and of the Indian must be precisely alike. I understand this to be true of the out-cropping of veins of quartz in the slate in the neighborhood of Little Falls, Minnesota. No one doubts that Indian relics are found in that vicinity, as is always the case at all good fishing sites like that. But Indian implements and palæolithic implements are very different in appearance, and no skilled archæologist will mistake one for the other. I have seen palæolithic implements that Miss Babbitt said she had found in undisturbed glacial deposits. This is positive, undisputed testimony. What has Mr. Holmes to say in answer to it? I will quote his words precisely: "My investigations have shown that the glacial quartzes were probably not originally included in the loam but rather that they were introduced into it in post-glacial times, and that they were rude because mere shop refuse, the period of occupation thus, in all probability, corresponding to that of our historic aborigines." This may be very convincing to some people, but to my mind it is not quite satisfactory. Professor Winchell says that the quartz fragments are to be found over a very extensive region, "up and down the river an unknown distance," and extending "downward three or four feet" in "hard-pan drift containing boulders." That is something quite different from "loam," the word persistently employed by Mr. Holmes in speaking of the fragments. Loam is defined by Webster as meaning "a mixture of clay and sand with organic matter to which its fertility is chiefly due." If this is the nature of "hard-pan drift, containing boulders," I am incapable of understanding ordinary language. Professor Winchell's words can only be understood of undisturbed glacial deposits. But Mr. Holmes says "there is nothing in the conditions and phenomena of the site that will enable us to say whether the beginning of the quartz-working dates back one hundred or one thousand years." He reaches this sweeping conclusion by imagining that Indian refuse from the surface has been introduced into this "hard-pan" by sinking through the decaying substance of the roots of large trees that have been uprooted by a tornado. Let me quote his own words: "The explanation thus furnished of the distribution of the worked quartzes of this locality through the glacial deposits to the depth of four feet or more is so satisfactory that no other theories are called for, and little further discussion seems necessary." To my mind this explanation is just as satisfactory, and no more so, than Mr. Holmes's former explanation that "most of the so-called gravel implements of Europe are doubtless the rejects of manufacture."

Mr. Holmes first draws pretty pictures, and then draws from them the conclusion that "the record may be so altered in the period of a generation as to be read ten thousand years instead of fifty. Such is the magic of Nature's transformations, and such are the pitfalls set for unwary explorers." Miss Babbitt, the "unwary explorer" in the present instance, is no longer living to defend herself from such assumption as this, but I think all lovers of justice will feel that this is a pretty weak answer to her positive assertions. Mr. Holmes continues: "The mistakes made by Miss Babbitt are precisely such as others have made through taking

up investigations in the geologic department of archæology without adequate knowledge either of the processes and phenomena of geology, or of the arts and habits of our aboriginal peoples." I had supposed that such crass ignorance as this was confined, in Mr. Holmes's judgment, to myself; but it seems that there are others falling under a like condemnation. How fortunate it is for the rising generation that Mr. Wm. H. Holmes has appeared to set them quite right in regard to the prehistoric archæology of North America. HENRY W. HAYNES.

Boston, May 22.

Preliminary Note on Eggs of Cottus Richardsoni.

ONE finds in scientific literature so little relating to the habits of even some of our best-known fishes, that reliable information on piscine life-histories is much to be desired.

The little miller's thumb (*Cottus Richardsoni*, Agassiz) was found breeding plentifully in a large spring near Philadelphia on Apr. 29, and a fine lot of material for future embryological study procured.

The places selected for oviposition were invariably the fountain-heads of small, lateral springs which emptied into the main body of water, and where the water was freshest and coldest. No eggs were found at more than a few feet distance from a spring-head. In two or three cases the streams were so tiny that the fishes must have been forced almost to squirm along to the nesting-place. The greatest number, however, were found where a powerful current flowed from beneath an overhanging rock.

A passage is forced beneath a stone, which may be a mere pebble or a large boulder, and a small, shallow chamber hollowed out of the underlying soil, unless the stone be so supported that a natural chamber is formed beneath it. This accommodates the fishes during egg-laying and impregnation; and later serves the male as a resting-place. To the under side of the stone, which forms the roof of the chamber, the eggs are attached, not singly and in small clusters arranged in a single layer, as is the case with Batrachus and other fishes of similar habit, but in an irregular, coherent mass, in which the eggs are often piled up five or six deep, but in most cases are only two or three. The eggs, while very firmly coherent, are loosely arranged, giving the mass a very porous structure, which permits a free flow of fresh water. This is the more necessary since the eggs deeper in the mass are sometimes the first to hatch, when they frequently escape through the passages between the more superficial ones, the collapse of their own egg-membranes making additional room for those which follow. The number of eggs, and consequently the size and shape of the masses, varies, the eggs numbering from 120 to 500. In most cases all of the eggs in a mass were of approximately the same age; but several times, eggs in two or three stages of development were found together, the deepest, of course, being the most advanced. In the cases of most fishes, as is well known, the eggs all hatch, under favorable conditions, at the same time. Whether the several lots are deposited by different females, or whether the eggs are matured in several batches, and the female returns to complete oviposition, I cannot say.

The eggs when newly deposited are of a delicate, translucent, pink color. They average one-tenth of an inch in diameter, being large for the fishes' size, but are quite variable, and are often misshapen by contact with their fellows. As usual, the axis of the embryo passes through the lowermost pole, the dark, widely separated eyes being prominent objects on this side of the egg. There is no regularity about the direction of the embryonic axis, which, in the different eggs of a mass, is found to point in every direction.

Some of the eggs hatched while being conveyed home, and the young lived several days in an aquarium jar. They are very active little creatures, darting about in a most lively manner, often swimming to the surface and then sinking to the bottom, where they rest for a moment, before undertaking another excursion. This activity is exhibited from the time of hatching. When first hatched they are nearly a quarter of an inch long and far advanced in development. The pigmentation is very slight, there being no prominent aggregations of chromatophores anywhere except in the eyes, which are densely pigmented. Branched pigment cells are scattered sparingly, especially on the dorsum of the head.

In every case the eggs were attended by the males, which showed no disposition to desert their posts, but remained motionless, trusting to their protective coloration for concealment.

Several of these males, which were thrown alive into a satchel, seemed to suffer no inconvenience whatever through their absence from water for three hours, but were at once active when placed in a dish. J. PERCY MOORE.

Gophers and Moles.

IN the course of his interesting "Observations on Gophers and Moles" in your issue of April 28, Mr. F. L. Washburn makes mention of two moles which were fatally poisoned by eating worms taken from an old manure heap. I presume that the Oligocheta there identified as *Lumbricus fœtidus* are equivalent or closely allied to those known to fishermen on this side of the water as "brandlings" (*Allolobophora fœtida*), commonly found under manure and readily distinguished from the common earthworm (*Lumbricus terrestris*) by their display of brilliant red rings; and if this be so, I can add my testimony — founded on disastrous personal experience — that the unsavory annelid is toxic also to reptiles. This is somewhat remarkable, seeing that it is devoured with impunity by fish and amphibians. During a severe and prolonged frost, six or seven winters ago, when frogs and common earthworms were not to be obtained, I incautiously tendered a number of these brandlings to certain colubrine snakes, wild with hunger from enforced abstinence after casting their sloughs; they included several mocassins (*Tropidonotus fasciatus*), a Bordeaux snake (*Coronella girondica*), two garters (*Tropidonotus ordinatus*), two or three specimens of *Lamenis atrovirens*, and a whole brood of little Japanese vibakaris (*Tropidonotus vibakari*), born in my vivarium and the sole representatives of the species in Europe. The result was that within a very few minutes the whole lot, as well as a couple of South African slowworms and a large apadous lizard, the "glass snake" so-called (*Pseudopus pallasi*), were in violent convulsions; and although by prompt and vigorous measures I forced them to disgorge and got them all into hot baths as speedily as possible, I lost eight out of my forty-three vibakaris, the Bordeaux snake, both slow-worms, one dark green, and one garter— hideous evidence of the baleful virulence of the *fœtidæ* and the lamentable lack of instinctive discrimination on the part of the reptiles. Evidently the conspicuous coloration of this worm is not to be added to the list of protectives, since the creatures to which it is most exposed, frogs, toads, etc., prey on it with avidity. Serpents, as a rule, will not take worms unless they have been "taught" to do so — such tuition, however, being quite practicable. ARTHUR STRADLING, C.M.Z.S., etc.

Watford, England.

BOOK-REVIEWS.

Destructive Distillation. A Manualette of the Paraffin, Coal Tar, Rosin Oil, Petroleum, and Kindred Industries. By EDMUND J. MILLS, D.Sc. (London), F.R.S. Fourth edition. London, Gurney & Jackson. 200 p. 8°.

HISTORICALLY an ancient industry, this branch of scientific investigation has always proved most absorbing and as early as the sixteenth and seventeenth centuries upon it was concentrated the whole attention of the laboratory. Heat was considered in the medium of a reagent and in the retorts of the alchemists vegetable, animal, and mineral matter was subjected to "analysis." The above work by Dr. Mills, now in its fourth edition, with improvements including the results of much additional research, is founded upon a course of lectures delivered in Anderson College, Glasgow, and is illustrated by actual inspection of many of the processes referred to. Since the appearance of the first edition, in 1887, the book has found its way into the hands of every technical student and every chemist the world over. Dr. Mills has become a recognized "authority" upon the subject, deserving and receiving the highest praise for his patient, earnest research. The main sections of the book are indicated by the title,

the kindred industries embracing Wood Tar, Asphalt, Ozokinite, Peat, Lignite, Bone Oil, Fixed Oils, Cellulose, etc. Appendix A provides a description of the six principal types of shale retorts, each being illustrated by a figure, and appendix B furnishes a complete bibliography of destructive distillation in its modern development. A neat summary describes the application of heat to cellulose and kindred bodies as leading to cumulative resolution, the process being in principle the same whether performed by nature or by human contrivance. At a high temperature the liquid distillate is characteristically "aromatic"; at a low temperature "fatty." In either case the persistence of the n C_8 group can be freely traced throughout. Inasmuch as a chemical equivalent for much of the "temperature" can be found in "time," petroleum may appear in rocks never actually igneous; and we can understand the occurrence of degraded hydrides, such as turpentine and other "aromatic" compounds in living trees.

C. P.

Poole Brothers' Celestial Handbook and Planisphere. Compiled and edited by Jules A. Colas. Chicago, Poole Brothers.

THE above publication is made up of two parts, the Handbook and the Planisphere.

The planisphere consists of a stiff, circular cardboard, about twenty inches in diameter, upon which has been engraved all the principal constellations that can be seen from the North Pole to 50° south declination. Fastened to the circular disc is a frame made of the same substance, and formed so as to project the horizon upon the sky, and also to assist in noting the days of the year. The planisphere is exceedingly handy, as the explanations printed upon it suffice for finding the approximate time at which any celestial body rises, culminates, or sets. In the hands of the learner of the constellations the planisphere is a great improvement upon the ordinary star-maps.

The handbook, which serves as a companion to the planisphere, contains in a neat form references to the principal constellations, the interesting double stars, the same being neatly illustrated, and the brighter nebulæ and star clusters. Short notes are given which contain the names, magnitudes, distances, and colors of the doubles. Tables are also to be found, giving the names of the bright, fixed stars, the principal binaries, colored stars, and those having a parallax. These are followed by short sketches of the phenomena of shooting stars, the principal periodic comets, and those that have an interesting history, and, last, the principal planets.

As Mr. Colas has simply compiled the remarks in the handbook, it is possible for one to find certain statements that may be questionable. He has probably fallen into pitfalls by following too closely some of the writings of Flammarion. For example, the statement that the earth and moon as seen from Sirius would appear as a spot is exceedingly misleading. A simple calculation would show that from the boundary of the solar system, that is, from Neptune, the moon as seen from that point would never depart more than 18 seconds of arc from the earth.

We note that Arcturus and Alpha Bootis are mentioned as if they were two distinct stars. This is probably a slip of the pen, as well as the statement that the constellation Cassiopeia can be seen every day.

The author has carried his book well down to date, as mention is made of Barnard's discovery of the fifth satellite of Jupiter, and Anderson's discovery of the new star in Aurigæ.

In our opinion the statement quoted from Flammarion's "Les Etoiles," that Baron Dembowski observed the yellow companion to 15 Lyncis covering the blue one by one-fourth of the former's diameter, is exceedingly doubtful.

A star, as seen in the most powerful telescope, is a point of light, never a disc, and such statements as the above are, to say the least, misleading.

The compiler has, in a note on Neptune, raised the question of priority of the discovery of the position in which the outermost planet would be found.

CALENDAR OF SOCIETIES.

Agassiz Scientific Society, Corvallis, Ore.

May 10.—Dumont Lotz, Food Adulterants.

May 31.—Wallis Nash, Darwin's Life and Works.

We would say that perhaps Mr. Colas was led by sentiment to make the unqualified statement that all the glory of the great mathematical computation, for that it was, rests with Le Verrier. The statement, however, is very questionable.

In glancing through the pages of the handbook, we can but admire the neatness with which the text has been arranged, and the selection of interesting objects gives a field of wide range.

We would recommend these two publications to the ambitious learner of the starry heavens as fit companions for his watches.

G. A. H.

Missouri Botanical Garden. Fourth Annual Report. St. Louis, 1893. Plates. 226 p.

THIS is a handsomely gotten up volume, in which we find several papers of interest. The report of the director, Dr. William Trelease, shows a flourishing condition of affairs. The herbarium now contains some 203,000 specimens, and the library over 11,000 volumes and pamphlets. The valuable library of Dr. Lewis Sturtevant was received as a donation, and included many manuscript notes. The only condition was that he retain the books during his lifetime or for so long a time as he needed them. The third annual flower sermon and the proceedings at the third annual banquet are reported in full. In the latter we find many interesting statements respecting Mr. Henry Shaw, the founder of the garden. There are also two scientific papers: "List of Plants Collected in the Bahamas, Jamaica, and Grand Cayman," by A. H. Hitchcock, and "Further Studies of Yuccas and Their Pollination," by Wm. Trelease.

Professor Hitchcock discusses in his introductory remarks various principles of nomenclature, finally taking 1753 as the starting point, in accordance with the recommendation of the Botanical Club of the A. A. A. S. The double citation plan is followed, the original author of the name being placed in parenthesis, the name of the author of the combination coming last. The original spelling of the specific name has been followed, except in those cases where typographical errors were clearly apparent. Notes are given on many of the species and several new ones are described. The relationship of the flora to the surrounding region is also discussed, and notes are given upon geographical distribution. Dr. Trelease's paper gives descriptions of the various species of *Yucca*, and mentions the mode in which some of them are fertilized. He agrees with Professor Riley that fertilization takes place through the intervention of species of *Pronuba*. He considers *Yucca whipplei* to belong to the genus *Hespero-Yucca*, the common Spanish Bayonet of San Bernardino region being considered as var. *graminifolia*. This variety is fertilized by a new form of *Pronuba*, described as *P. maculata*, var. *aterrima*.

J. F. J.

THE lists of expectant graduates of Sibley College, Cornell University, in mechanical engineering, are just published by the registrar. The total number of candidates for the first degree is just one hundred; for the second degree, twelve come up, and are already, in most cases, through their examinations. Two or three of the first-degree men may fail; but the total will exceed one hundred. The graduating class, for the whole university, inclusive of its law school and special courses of four years' length, will be considerably above three hundred. There are about two hundred graduate students on the catalogue, a large proportion of whom take their degrees this year. Of these, many take the first degrees in Sibley College, where the custom of going through the regular "general courses" before entering the professional school is rapidly gaining ground, and is greatly encouraged by the authorities — where the student can afford the time and the expense.

—The Contemporary Publishing Co. have just issued an important work on the subject which to-day most attracts the attention of geographers: "The Arctic Problem and Narrative of the Peary Relief Expedition," by Professor Angelo Heilprin, the leader of the expedition.

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York.]

For sale or exchange.—One latest complete edition of Watt's Dictionary of Chemistry, in fair condition; one thirty volume edition (9th) of Allen's Encyclopædia Britannica, almost new. Will sell cheap for cash or will exchange for physical or chemical apparatus. Address Prof. W. S. Leavenworth, Ripon College, Ripon, Wis.

Exchange.—One celestial, one terrestrial globe, one lunatettis and charts, celestial maps, diagrams and ephemeris from 1830 to 1893, astronomical works, all in good condition. Will sell cheap or exchange. Make offer. C. H. Van Dorn, 79 Nassau St., New York.

The Rev. A. C. Waghorne, New Harbor, Newfoundland, wishes to sell collections of Newfoundland and Labrador plants, all named by competent botanists. He is going on a missionary journey along the Labrador coast, from the middle of July till October, and in return for much needed aid towards (Episcopal) Church purposes in that region, will be glad to be of service to any botanists who may write to him. Letters posted in the U. S. up to July 1 will reach him at the above address, and if posted later will be forwarded.

For sale.—J. D. Dana's Report on Crustacea of the U. S. Exploring Expedition under Charles Wilkes. Text and plates well bound in three volumes, half morocco, $75. Samuel Henshaw, Boston Society of Natural History, Boston, Mass.

For exchange—I wish to exchange cabinet skins of Californian birds or mammals for any book on the following list, books if second-hand to be in good order. Manual of Vertebrates, fifth edition, D. S. Jordan; Nests and Eggs of North American Birds, Oliver Davie; Marine Mammals of the West Coast of North America, C. M. Scammon; The United States and Mexican Boundary Survey, Vol. II., Zoology, S. F. Baird. F. Stephens, Witch Creek, San Diego Co., Cal.

Minerals for exchange—John Holl. Rollo, Wilmington, Delaware.

For sale or exchange.—Johnson's Universal Cyclopædia, 8 vols., ed. 1888. Binding, half-morocco. Will sell cheap for cash or would exchange for typewriter. Address W. J. McKom, Mason, Mich.

I have 500 microscopic slides to exchange in lots to suit. Want Kodak, first-class field-glass or scientific books. A. C. Gruhlke, Waterloo, Ind.

For sale or exchange—A Telescope (36 diameters, copper barrel)—for $20 cash or scientific books of that value. A. N. Somers, La Porte, Ind.

Wants.

WANTED. — Second-hand copy of Ehrenberg's Radiolaria, Berlin, 1875. Selected diatom slides, cash or both in exchange. D. C. Lewis, M.D. Skaneateles, N. Y.

WANTED, as principal of a flourishing technical school, a gentleman of education and experience who will be capable of supervising both mechanical and common school instruction. Special familiarity with some technical branch desirable. Address, giving age, qualifications, etc., J. B. Bloomingdale, Fifty-ninth street and Third avenue, N. Y.

WANTED.—A young man as assistant in our microscopical department. Queen & Co., Philadelphia.

THE undersigned desires specimens of North American Gallinae in the flesh for the study of their pterylosis. These species are especially desired: *Colinus ridgwayi, cyrtonyx montezumae, deudragapus franklini, lagopus welchi, tympanuchus cupido* and *pedioecetes phasianellus*. Any persons having alcoholic specimens which they are willing to loan or who can obtain specimens of any of the above are requested to communicate with Hubert Lyman Clark, 3922 Fifth Avenue, Pittsburgh, Pa.

A COMPETENT TEACHER of botany in college or university is open to engagement. Address L., Box 86, Rochester, Mich.

CAN any one inform me as to the age to which cats have lived? I have one twenty years old. Edward D. Webb, 132 W. Eighty-first St., New York.

WANTED — Second-hand. Foster's Physiology, Balfour's Comparative Embryology, Claus & Sedgwick's Zoology, Flower's Osteology of Mammalia, Vine's Physiology of Plants. Please state editions and prices asked and address Richard Lees Brampton, Ontario, Canada

A GRADUATE ENGINEER will give instruction evenings in geometry, trigonometry and surveying, mechanics, physics, mechanical drawing and general engineering construction. Five years' experience in field and editorial work on engineering journal. References furnished. C. S. H., 102 Tribune Building, New York.